

EXHIBIT 5



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prepared at the request of counsel for defendants in

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At levels in excess of the eight-hour and previous one-hour NAAQS, ozone is an irritant to the lungs and eyes. At sufficiently high concentrations, it can cause shortness of breath. Exposure to excessive ozone levels can also aggravate asthma, emphysema, and other conditions. Prolonged exposure to high ozone concentrations can cause permanent reductions in lung function. Ozone also causes damage to materials (e.g., rubber cracking), agricultural crops, and forests. Although some ozone is created naturally, typical natural background concentrations at ground level are in the range of 0.04 ppm, which is not a sufficiently high concentration to cause adverse health effects or other adverse environmental impacts.

As noted above, high ambient concentrations of ozone, the principal constituent of smog, result from a complex series of photochemical reactions involving VOCs and NO_x. VOCs are emitted from a wide variety of natural and anthropogenic sources, including gasoline-fueled on- and off-road mobile sources. In contrast to high ambient CO concentrations, which tend to be localized, high ambient ozone levels are generally a regional problem. Ozone nonattainment areas, particularly along the east coast of the U.S., can be comprised of areas in several states. In urban areas that violate the ozone NAAQS, high levels of ambient ozone are generally limited to summer months, when sunlight is more prevalent and intense and ambient temperatures are higher.

Air Pollutant Emissions from Mobile Sources

Mobile sources are a diverse group of vehicles and equipment, most of which are used for transportation purposes. This group is frequently subdivided into two categories: on-road and off-road, or “non-road,” mobile sources. The on-road mobile source category is comprised of the following vehicle classifications:

1. Motorcycles;
2. Passenger cars;

3. Light-duty trucks;
4. Medium-duty vehicles; and
5. Heavy-duty trucks and buses.

Most on-road mobile sources, with the exception of heavy-duty trucks, operate on gasoline.

The non-road category includes sources such as the following:

1. Recreational vehicles, such as off-road motorcycles and all-terrain vehicles;
2. Marine vessels and pleasure craft;
3. Construction and farm equipment;
4. Locomotives;
5. Aircraft and aircraft service vehicles; and
6. Lawn and garden equipment, such as lawnmowers and weed-whackers.

Many of the engines in the non-road category are Diesel-fueled; however, recreational vehicles, pleasure craft, and lawn and garden equipment primarily use gasoline-fueled engines. It should also be noted that most gasoline-fueled non-road engines are refueled using portable gasoline containers, which can be important sources of VOC emissions.

Mobile sources generate emissions of air pollutants through both combustion and fuel evaporative processes. Combustion products include CO, VOCs, and NO_x. CO and VOCs are the result of incomplete fuel combustion, which is especially a problem during starting and warmup operation in cold weather. NO_x is formed primarily as the result of the high temperatures associated with combustion in the engine.

Evaporative VOC emissions include emissions related to the vapor losses from the fuel tank and fuel system during normal operation and while the vehicle is parked; the displacement of gasoline vapors from the fuel tank during vehicle refueling; and the permeation of fuel through plastic and rubber fuel system components, including vehicle fuel tanks and portable fuel containers. The magnitude of evaporative emissions depends in large part on the volatility of gasoline sold in an area. This volatility is usually

characterized using a metric referred to as Reid vapor pressure (RVP). Higher RVP gasoline is more volatile and will have higher evaporative emissions, all other things being equal. Permeation losses depend on the chemical properties of gasoline. The presence of ethanol in gasoline has been shown to substantially increase permeation emissions in many existing sources.

It has long been recognized that mobile sources contribute significantly to air quality problems, including elevated ambient CO and ozone concentrations. As a result, there is a long history of regulatory efforts intended to reduce mobile source emissions.

There are three basic ways in which emissions from mobile sources are controlled: requiring certification to emissions standards applicable to new vehicles and equipment, enforcing compliance with emissions standards in customer service, and requiring the sale of fuel meeting specifications designed to reduce emissions. The certification process requires manufacturers to demonstrate that their products meet applicable emission standards when new and that they will continue to meet the standards after some form of durability testing.

Programs designed to ensure compliance with emissions standards in customer service involve both random and routine emissions testing. If the testing of a random sample indicates that a particular vehicle model or product, despite being properly maintained, is failing to meet standards, EPA or the California Air Resources Board may order the manufacturer to conduct a recall and make corrective repairs. More routine testing is performed under the inspection and maintenance (I/M) programs for on-road vehicles that operate in many states. I/M programs target vehicles with emissions-related malfunctions, emission systems that owners have tampered with, and vehicles that owners have failed to properly maintain. Depending on the age of the vehicle and the

type of emission problem (e.g., a malfunction or tampering), manufacturers or owners must pay for the repairs needed to return emissions to normal levels.

The establishment and enforcement of fuel specifications has long been recognized as a critical element of the mobile source emissions control program. Mobile sources are certified to meet emissions standards using a fuel that meets a variety of precisely defined specifications. Emissions performance in customer service depends on whether the fuels being used meet equal or more stringent specifications.

The 1990 Clean Air Act Amendment Requirements for Oxygenated and Reformulated Gasoline

The 1990 Clean Air Act Amendments included provisions requiring the establishment of two programs intended to alter the composition and properties of gasoline in order to reduce emissions from gasoline-fueled mobile sources: the Oxygenated Fuels requirements in Section 211(m) of the Act, and the Reformulated Gasoline requirements in Section 211(k) of the Act. These requirements mandated changes in gasoline composition in certain areas of the country where high levels of CO and/or ozone were observed, including the New York City Metropolitan Area (NYCMA).

Oxygenated Fuels - The Oxygenated Fuels requirements in Section 211(m) are applicable to areas that had ambient CO “design values”² with respect to attainment of the eight-hour CO NAAQS of 9 ppm or greater based on ambient air quality monitoring data during the two-year period from 1988 and 1989, or any area subsequently found to have a design value above 9.5 ppm based on two years of ambient CO data.

The basic requirement was that states with areas subject to the Oxygenated Gasoline requirements based on the CO design value criteria must adopt SIPs that included regulations requiring that gasoline sold during certain winter months contain at

² See <http://www.epa.gov/air/oaqps/greenbook/laxton.html> for a discussion of eight-hour CO design values.

least 2.7% oxygen by weight. In order to contain 2.7% oxygen by weight, a gasoline must contain approximately 15% MTBE by volume, the maximum amount of MTBE allowed to be added to gasoline by the U.S. EPA. Ethanol may be added to gasoline at up to 10% by volume, which translates to approximately 3.5% oxygen by weight.

For areas with 1988-1989 design values in excess of 9.5 ppm, oxygenated gasoline was required beginning on November 1, 1992, and every winter thereafter until the area came into attainment with the CO NAAQS and continued attainment with the CO standard in the absence of oxygenated gasoline could be demonstrated. Also of note is that oxygenated gasoline was required in the entire Consolidated Metropolitan Statistical Area or Metropolitan Statistical Area in which the CO nonattainment area was located, not just the area designated as being in nonattainment with the CO NAAQS.

Reformulated Gasoline - Section 211(k) of the Clean Air Act Amendments of 1990 established requirements for a reformulated gasoline program that mandated changes in the composition of gasoline used in selected ozone nonattainment areas. Section 211(k) directed EPA to adopt regulations for reformulated gasoline, which it did in February 1994.³ These regulations are codified in 40 Code of Federal Regulations (CFR), Part 80, Subpart D and took effect in January 1, 1995, as specified in Section 211(k).

Section 211(k) also established some of the requirements for reformulated gasoline, including that it contain at least 2% oxygen by weight on a year-round basis. This mandatory requirement regarding the oxygenate content of reformulated gasoline was in place from the January 1, 1995 effective date of the program through the 2006

³ 59 FR 7716, February 16, 1994

repeal of those requirements.⁴ In order to achieve 2% oxygen by weight in a gasoline, approximately 11% MTBE by volume must be added or about 5.75% ethanol by volume must be added.

The reformulated gasoline program is intended primarily to reduce emissions of VOCs and NOx as a means of reducing ambient ozone levels. In addition, the regulations require changes in gasoline composition to reduce emissions of toxic compounds. Under the reformulated gasoline regulations, refiners must change the composition of gasoline in such a way that emissions of VOC, NOx, and toxics are reduced by specific amounts relative to a baseline gasoline representative of the average gasoline marketed in 1990.

The federal reformulated gasoline program is composed of two “phases,” which have different emission reduction requirements. The first phase spanned the period from 1995 through 1999, and the second phase (referred to as “Phase II”) began in 2000. Compliance with the current Phase II reformulated gasoline requirements is determined using the Phase II version of the U.S. EPA’s “Complex” model. The Complex model is used to evaluate the emission reductions in VOC, NOx, and toxics emissions that would result from a specific gasoline formulation relative to the 1990 baseline gasoline. The Complex model evaluates the emissions performance of reformulated gasolines based on the following fuel properties:

1. RVP,
2. Oxygen content and oxygenate type,
3. Benzene content,
4. Aromatic content,
5. Olefin content,
6. Sulfur content, and
7. Distillation properties (E200 and E300).

⁴ 71 FR 26691, May 8, 2006

The reformulated gasoline regulations also contain provisions to assure that conventional gasoline sold in other areas does not change in a way that would increase emissions relative to the 1990 baseline gasoline. These are referred to as “anti-dumping” restrictions.

Available Oxygenates and Emissions Attributes

There are a number of oxygenate compounds that could have been and were used in varying degrees to produce the oxygenated gasolines mandated under the federal Oxygenated Fuels and Reformulated Gasoline programs. These include those listed below.

1. MTBE
2. Ethanol
3. Tertiary Amyl Methyl Ether (TAME)
4. Ethyl Tertiary Butyl Ether (ETBE)
5. di-Isopropyl Ether (DIPE)
6. Tertiary-Butyl Alcohol (TBA)

Many of these compounds—MTBE, TBA, and ethanol, in particular—had already been investigated and used as gasoline additives prior to the 1990 Clean Air Act Amendments.⁵

As is well known, MTBE became the oxygenate of choice for compliance with the federal Reformulated Gasoline program and, to only a somewhat lesser extent, the federal Oxygenated Fuels program. There were a number of reasons for choosing MTBE, including some related to economics and the logistics of gasoline production and distribution.⁶ However, the properties and characteristics of MTBE also allowed the Oxygenated Fuels and Reformulated gasoline programs to achieve substantial reductions

⁵ See, for example, “Alcohols and Ethers, A Technical Assessment of Their Application As Fuels and Fuel Components,” API Publication 4261, Second Edition, July 1988.

⁶ MTBE Briefing Paper Prepared by the California Environmental Protection Agency, April 24, 1997 and Updated September 3, 1998.

in mobile source emissions of CO and the ozone precursors VOCs and NO_x. Of particular importance are the additional reductions in mobile source VOC and NO_x emissions realized from the use of MTBE instead of ethanol.

With respect to ethers TAME, ETBE, and DIPE, MTBE (which is also an ether) has similar physical and chemical characteristics. From the perspective of mobile source emission reductions, there is little difference among these four compounds, although MTBE is generally less photochemically reactive based on the well-known Carter Maximum Incremental Reactivity (MIR) scale⁷ and it has a better blending octane rating and provides for higher E200 and E300 values.⁶ The oxygen content of MTBE is somewhat higher than that of the other ethers, meaning that they achieve somewhat greater dilution effects at equal oxygen content.

The alcohols ethanol and TBA have differences in their physical and chemical properties that cause them to be inferior to MTBE in terms of the mobile source emission reductions they provide. While the discussion below focuses on ethanol (by far the alcohol most widely used as a gasoline additive), TBA suffers from similar, although somewhat less significant, issues.

One major concern with the use of ethanol as a gasoline additive is the effect of alcohol on the front-end volatility of the gasoline as determined using the RVP metric. It is well known that diluting gasoline with 5-10% ethanol increases RVP by approximately 1 psi. Higher RVP values mean that the fuel is more volatile or, in other words, higher RVP values indicate that the fuel will evaporate more readily at a given temperature, all else being equal. Figure 1 shows a typical curve of RVP change in response to the

⁷ See VOC Reactivity Data at <http://helium.ucr.edu/%7Ecarter/reactdat.htm#data>